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Treating low strength/high flow landfill gas in an active loaded biofilter

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Background

Landfill gas (LFG) contains methane (CH_4), which is a 28 times stronger greenhouse gas than carbon dioxide (CO_2) when considering a time horizon of 100 years (Core Writing Team et al., 2014). Due to the explosion risks from CH_4, LFG is at some landfills collected and vented directly to the atmosphere to avoid off-site LFG migration to nearby residential areas. These collection and venting systems could lead to diluted landfill gas were treatment is still needed. Cost-efficient technologies for treatment of low strength LFG is limited. A treatment solution could be active loaded open biofilters with compost material supporting the oxidation of CH_4, and where the inlet gas containing LFG is mixed with atmospheric air. Oxygen in the inlet will make it possible to activate a larger part of the filter material and not only the upper part as what is often seen in landfill biocovers receiving raw LFG containing 50-60% CH_4.
At Hedeland landfill, Denmark, horizontal LFG migration is prevented by installation of vertical boreholes at the border of the landfill were soil gas is collected and vented directly to the atmosphere. In this project an open pilot-scale biofilter was constructed to test its efficiency of oxidizing methane in the collected soil gas. The concept is similar to what was constructed at AV Miljø (another Danish landfill), where the filter was loaded with diluted LFG from leachate wells (Cassini et al., 2017; Scheutz et al., 2017). However, at the Hedeland biofilter the methane loads are much higher than at the AV Miljø biocover.

Research objective

The research objective is to define a design criterion for the size of a biofilter to oxidize dilute LFG. The filter will be loaded with methane in the range from 135 g CH_4 m^{-2} d^{-1} to 1400 g CH_4 m^{-2} d^{-1}.

Experimental Setup and Preliminary Results

The compost filter is made in an open 30 m^3 container. The filter is constructed with a 40 cm gravel layer in the bottom with perforated pipes for gas distribution and a 120 cm compost

layer on top, resulting in a filter of approximately 15 m^3. To be able to measure the gas composition at different locations in the filter, horizontal multi-level samplers (MLS) were constructed including nine measuring points in six depths. Sensors registering temperature and moisture were installed at two points in three depths in the compost and connected to data-loggers storing the data every half hour. The CH_4 content in the treated LFG is also registered and logged every half hour and the flow of LFG and air are registered.
For measurements of the total flux out of the filter, a flux chamber covering the whole surface of the filter was constructed.
The treatment of LFG in the filter was started mid-March 2018, before that background measurement was conducted, were the gas composition was registered in the installed multi-level sampler and in the inlet of the filter. The flux of CH_4 and CO_2 at the surface of the filter was also measured using the flux chamber. Background measurements were conducted before any air or gas was fed to the filter, and gas concentration profiles and flux measurements showed elevated carbon dioxide due to compost respiration. However, profiles also showed presence of O_2 throughout the filter material. Figure 1 shows the results of a background measurement of CO_2 and O_2 in the 54 MLS illustrated as a vertical profile through the filter.
At the time of the conference, results showing the gas composition in the filter at different CH_4 loads will be presented.

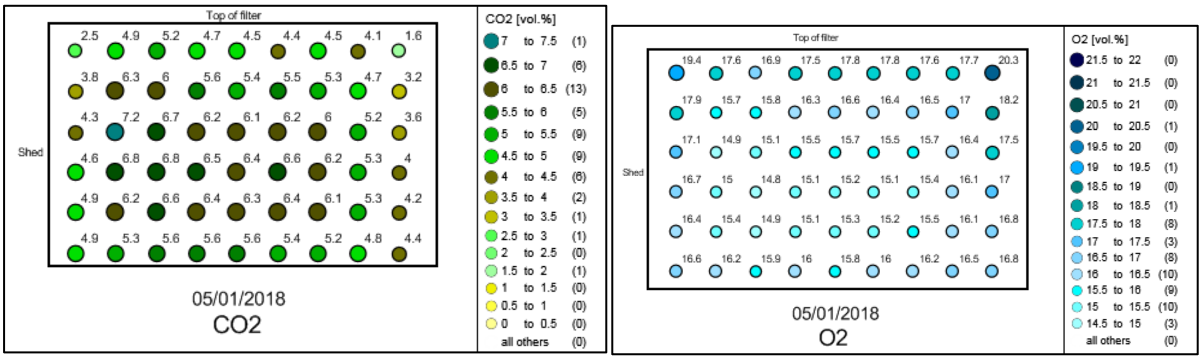

Figure 1. CO_2 and O_2 concentrations and distribution in the 54 MLS measured January 5th before any gas or air was loaded to the filter.

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